

AD-A089 677

BOEING AEROSPACE CO SEATTLE WA
HARDNESS ASSURED DEVICE SPECIFICATIONS. (U)

F/6 18/6

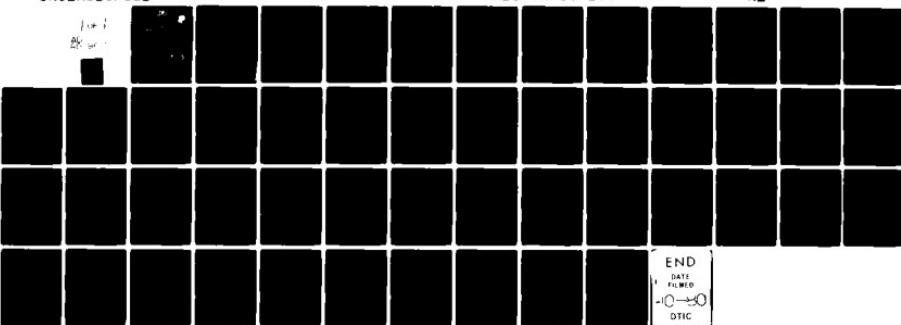
MAY 80 C J DIXON, F B MCGALLIARD

F30602-78-C-0325

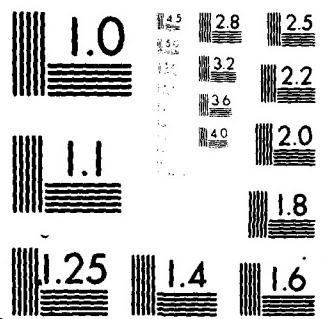
UNCLASSIFIED

RADC-TR-80-104

NL



END
DRAFTED
-10-
DTIC



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963 A

DDC FILE COPY

AD A 089677

5c
RADC-TR-80-104
Final Technical Report
May 1980

LEVEL II

12



HARDNESS ASSURED DEVICE SPECIFICATIONS

Boeing Aerospace Company

C. J. Dixon
F. B. McGalliard

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED

DTIC
ELECTED
S SEP 26 1980 D
E

ROME AIR DEVELOPMENT CENTER
Air Force Systems Command
Griffiss Air Force Base, New York 13441

80 9 29 105

This report has been reviewed by the RADC Public Affairs Office (PA) and is releasable to the National Technical Information Service (NTIS). At NTIS it will be releasable to the general public, including foreign nations.

RADC-TR-80-104 has been reviewed and is approved for publication.

APPROVED:

Clyde H. Lane

CLYDE H. LANE
Project Engineer

APPROVED:

David C. Luke

DAVID C. LUKE, Lt Col, USAF
Chief, Reliability & Compatibility Division

FOR THE COMMANDER:

John P. Huss

JOHN P. HUSS
Acting Chief, Plans Office

62707H

If your address has changed or if you wish to be removed from the RADC mailing list, or if the addressee is no longer employed by your organization, please notify RADC (RBRP), Griffiss AFB NY 13441. This will assist us in maintaining a current mailing list.

Do not return this copy. Retain or destroy.

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

(1) REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER ⑯ RADC-TR-80-104	2. GOVT ACCESSION NO. AD-A089 677	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) ⑮ HARDNESS ASSURED DEVICE SPECIFICATIONS.	5. TYPE OF REPORT & PERIOD COVERED Final Technical Report Oct 78 - Oct 79	
	6. PERFORMING ORG. REPORT NUMBER N/A	
7. AUTHOR(s) ⑯ C. J. Dixon F. B. McGalliard	8. CONTRACT OR GRANT NUMBER(s) F30602-78-C-0325	
9. PERFORMING ORGANIZATION NAME AND ADDRESS Boeing Aerospace Company P.O. Box 3999 Seattle King County WA 98124	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 62704F DNAR0301	
11. CONTROLLING OFFICE NAME AND ADDRESS Rome Air Development Center (RBRP) Griffiss AFB NY 13441	12. REPORT DATE May 1980	
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) Same ⑯ 950	13. NUMBER OF PAGES 50	
	15. SECURITY CLASS. (of this report) UNCLASSIFIED	
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE N/A	
16. DISTRIBUTION STATEMENT (of this Report) Approved for public release; distribution unlimited. ⑯ DNAR 2 299QAXTD072 ⑯ 1703, 1072		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report) Same		
18. SUPPLEMENTARY NOTES RADC Project Engineer: Clyde Lane (RBRP) This work sponsored by the Defense Nuclear Agency under Subtask Code 299QAXTD072 and Work Unit 69.		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Radiation Hardness Assurance Hardness Assurance Standard Hardness Assured Devices Hardness Assured Device Specifications		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) A proposed hardness assured device specification plan was prepared describing the tasks required to develop hardness assured device specifications and qualify parts within the existing military specification system. The activities required to prepare the specifications is described in the plan. The final report discusses the decisions made in preparing the plan, describes the cost savings from implementing the plan and includes the required changes to MIL-M-38510 MIL-M-19500		

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 68 IS OBSOLETE

UNCLASSIFIED

(Cont'd)

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

059619

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)

Item 20 (Cont'd)

and MIL-STD-883 to be compatible with the proposed detail specifications. A unique approach to specifying hardness assurance parameters was developed to permit only two hardness levels to satisfy all anticipated users. Variables percent defective statistical test methods are described which reduce the cost of testing.

(1)

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)

PREFACE

This final report was prepared by the Boeing Aerospace Company, Seattle, Washington, under contract F30602-78-C-0325. The work reported covers the period from October 1978 to October 1979. The report was prepared under the supervision of W. R. Rumpza with C. J. Dixon as technical leader. Major technical inputs were provided by Dr. Itsu Arimura, D. W. Egelkrot, and F. B. McGalliard. The RADC project engineer was Mr. Clyde H. Lane.

Accession For	
NTIS GRANT	<input checked="" type="checkbox"/>
DDC TAB	<input type="checkbox"/>
Unannounced	<input type="checkbox"/>
Justification	<hr/>
By _____	
Distribution/	
Availability Codes	
Dist.	Avail and/or special
A	

CONTENTS

	Page
1.0 INTRODUCTION	1
2.0 HARDNESS ASSURED DEVICE SPECIFICATION PLAN	3
2.1 Plan Development	3
2.2 Plan Summary	3
2.3 Major Issues	5
2.3.1 Characterization of Radiation Response	5
2.3.2 Sample Sizes and Statistics	7
2.3.3 Part Numbering	8
3.0 REVISIONS TO MILITARY SPECIFICATIONS AND STANDARDS	12
4.0 IMPLEMENTATION AND SCHEDULE	13
5.0 COST SAVINGS	18
Appendix A Comments on Draft Hardness Assured Device Specification Plan	21
Appendix B Changes to MIL-M-38510	27
Appendix C Changes to MIL-STD-883	32
Appendix D Changes to MIL-S-19500	35

ILLUSTRATIONS

	Page
Figure 2.3.1-1 Illustration of Three Types of Radiation Responses	6
Figure 2.3.2-1 Inspection by Variables for Percent Defective	9
Figure 2.3.3-1 Part Numbering	10
Figure 4.0-1 Program Implementation Costs	15
Figure 4.0-2 Program Schedule	16
Figure 4.0-3 Estimated Hardness Assurance Cost	17
Figure 5.0-1 Typical Program Hardness Assurance Cost Savings	20

EVALUATION

Boeing has provided a needed service to the Air Force, DoD and NASA by putting together a logical program for generating detail specifications for radiation hardness assured microcircuits. Ideas on how best to accomplish this goal have been generated by many people in the community over the years. This report brings many of those ideas together in a plan of action. Because of the increasing need for cost effective system hardening, this program should be implemented essentially as recommended in the report. It is another milestone in the semiconductor component standardization program.

The appendices of this report contain the recommended modifications to MIL-S-19500, the general specification for discrete semiconductor devices, and MIL-M-38510, the general specification for microcircuits. Implementation of the modifications will result in general specifications which will permit a logical, orderly treatment of military detail specifications for hardness assured devices.

The next step will be to provide a sufficient number of hardness assured, military qualified diodes, transistors and microcircuits to allow a designer to work primarily with standard qualified parts in meeting his system requirements. The payoff for both system acquisition and maintenance will be substantial. Boeing has addressed the next step in this report with an estimation of the cost of establishing a qualified parts list of military standard, hardness assured devices. Because of the high initial cost and the small, almost exclusively military requirement for such parts, it is imperative that all the services and NASA make a concerted effort to establish and use military standard, hardness assured parts. We cannot afford to

maintain custom parts for custom systems. DNA and the military standardization program have provided the only satisfactory way to handle the problem. The excellent effort of the Boeing people has given us a blueprint for generating an acceptable alternative to the piecemeal, splintered, costly approach now in use, where each system attempts to satisfy only its own requirements. Hopefully the pace of the DNA hardness assurance program will be quickened by triservice/NASA support for detail military specification generation per guidelines in this report and the JAN component standardization system.

Clyde H. Lane

CLYDE H. LANE
Project Engineer

1.0 INTRODUCTION

The requirements of many military and commercial systems include performance during and after exposure to nuclear radiation. The environments vary from those of nuclear weapon exposure to those associated with reactor control and space radiation. The cost of microcircuits and discrete semiconductor devices (parts) for these systems is very high because they are procured to custom specifications that require the part to perform in a certain way in the specific environment of each system. These costs can be reduced and availability can be improved, by developing standard hardness assured parts that meet the requirements of most government systems. The Defense Nuclear Agency (DNA) has been working towards this goal for several years, under its Hardness Assurance Program. Until now, this effort has been directed primarily toward developing standard methods for performing hardness assurance tests.

The purpose of this contract was to take the next step by developing a proposed hardness assured device specification plan for DOD/NASA consideration and coordination that explains in detail how to provide for such standard parts within the framework of the existing military specifications. The approach presented in the plan is to characterize the radiation response of existing and proposed mil-spec parts and add testing requirements to the general and detail specifications to assure that parts in future lots have equal or better response.

This final report provides a summary of the proposed hardness assured device specification plan and discusses the major decisions and trades that were made in developing it. It also includes, as appendices, drafts of changes proposed to the general specifications and standards for these parts, MIL-M-38510, MIL-STD-883 and MIL-S-19500, required to implement the plan.

To complete the process of making standard hardness assured parts available, the detail specifications must be revised to add the specific radiation response characteristics and hardness assurance testing requirements for each

part. This report includes the estimated costs and a recommended schedule for revising the detailed specifications. This effort is presently not funded.

2.0 HARDNESS ASSURED DEVICE SPECIFICATION PLAN

2.1 Plan Development

The first draft of the proposed hardness assured device specification plan was submitted in December, 1978, in accordance with contract requirements. The second draft, which contained additional technical details, was sent to government agencies, aerospace contractors, and part manufacturers for comment. Approximately 90 copies of the plan were distributed and 18 replies were received. Appendix A gives a list of the responders and a summary of their comments, which were incorporated into the final version of the plan. The final plan contains less detailed discussion of complicated examples of specification techniques and stresses description of the efforts required by the plan.

2.2 Plan Summary

The proposed hardness assured device specification plan defines all the required actions to be performed by various government agencies and government contractors to arrive at the point of having a selection of standard hardness assured microcircuits and discrete semiconductor devices (parts) listed on the qualified products lists and available for procurement. The plan presents a level of detail sufficient to define all the major problem areas which must be resolved to select, characterize, and prepare specifications for the parts. The plan outlines the procedures for qualification and quality conformance testing and defines the estimated cost/schedule for implementing the program on 100 microcircuits, 50 transistors, and 30 diodes.

The fundamental approach of the plan is to characterize the radiation response of existing mil-spec parts and then add requirements to the military specifications and standards covering those parts to assure that the parts in future lots have equal or better response. The first step in the plan is to select the parts for which hardness assured specifications should be prepared. The primary selection criteria is the level of projected usage on

future hardened systems. The second step in the plan is to characterize the radiation response of the selected parts. This requires collecting and evaluating existing data on the parts and performing any additional tests that may be required.

Parameters that define the radiation response will be selected to conclude the characterization effort. Further details of the characterization effort are discussed in section 2.3.1 below.

The selected specifications must be revised to add the radiation response parameters and the testing requirements to assure those parameters. This is a two step effort, requiring first a revision of the general specifications, MIL-M-38510 for microcircuits and MIL-S-19500 for discrete semiconductors, and the microcircuit qualification and quality conformance inspection requirements, MIL-STD-883, Method 5005. Drafts of these revisions were prepared under this contract and are included in Appendix B, D, and C respectively. The second step is to revise the detail specifications for each part to add the parameters that characterize the part's radiation response and the testing requirements to assure those parameters. Further details of the sampling and statistical approaches required for adequate hardness assurance are provided in section 2.3.2.

The final step in the plan is the qualification and quality conformance inspection of parts to the revised specifications. These inspections will be designed to be extensions of the present requirements for non-hardness assured parts. Sample parts will be selected from regular production lots and subjected to radiation tests, either at the manufacturer's facility or at an outside radiation test facility. Parts that pass the existing tests and the hardness assurance tests will be marked with a new part number. Parts that pass the existing tests but fail the hardness assurance tests will be marked with the existing military specification number. Further discussion of the part numbering system is provided in section 2.3.3 below.

2.3 Major Issues

2.3.1 Characterization of Radiation Response

The process of characterizing the parts contains several problem areas which impact the cost and technical feasibility of the program. In the detailed discussion of these points, the plan shows that each one is resolvable. The proliferation of part numbers which is caused by performing hardness assurance to each program-specific radiation environment may be controlled by using damage constants and actual performance limits, as described below, so that the radiation performance assured is not a function of the application.

There are three basic types of radiation response phenomena as shown in Figure 2.3.1-1. Type 1 is exemplified by primary photo-current and current gain degradation with neutrons. These parameters are well behaved and may be represented by simple mathematical models, such as damage constants, over a wide range of radiation environments. Type 2 is exemplified by MOS threshold voltage change with total ionizing dose and change of op-amp offset voltage with neutrons. These parameters may show marked anomalies, may not even be monotonic, and cannot, in general, be represented by a simple equation except over a quite limited range of radiation exposure. Type 3 is exemplified by logic functional failure and parameter response exceeding specific values at measured radiation levels. This category of parameters is described by the radiation level at which the response takes place. The characteristic may be described as the number of devices exhibiting the response at a radiation stress level. Where the response is dependent on some measurable electrical parameter, it may be possible to separate the variables and obtain an independent parameter.

During the characterization effort, the radiation response of all of the major electrical parameters that define each part will be identified as one of the three types just described, the appropriate parameter will be defined, a mean value of the parameter will be calculated, and the statistical distribution of the parameter over the group of parts used for characterization

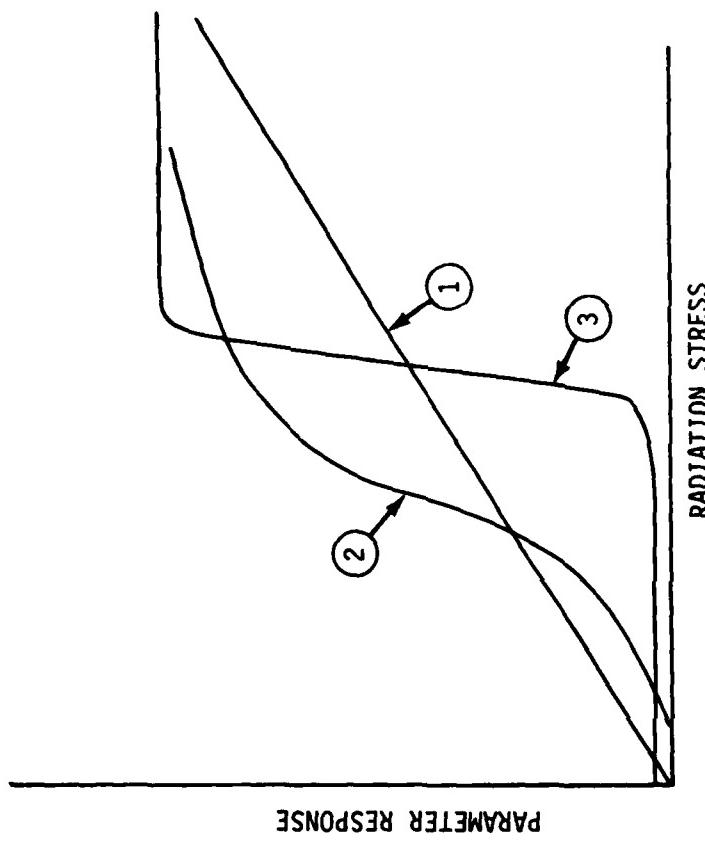


FIGURE 2.3.1-1 ILLUSTRATION OF THREE TYPES OF RADIATION RESPONSES

TYPE 1 - SMOOTH, FITTABLE

TYPE 2 - SMOOTH, UNFITTABLE

TYPE 3 - ABRUPT FAILURE

will be determined. This information will be used in development of the specification as described below.

2.3.2 Sample Sizes and Statistics

The complexity of the radiation environment is a serious problem when attempting to set up lot sampling tests. Assurance levels of 0.1% defective are needed to assemble a system with up to a thousand parts and still be able to survive the environment for most systems. Achievement of such assurance requires prohibitively large sample sizes, hundreds of parts per lot, if traditional lot tolerance percent defective (LTPD) statistics are used. Two alternatives are available to overcome this problem. For some parameters, modifications to the LTPD approach, which is based on inspection by attributes, must be made to reduce the sample sizes required. For parameters that are independent and normally distributed, inspection by variables, as described in MIL-STD-414, can be used to achieve even greater reduction in sample sizes.

For parameters that require inspection by attributes (i.e., the standard LTPD inspection), where the failure mechanisms are not lot oriented, maintenance of lot to lot data that shows that fewer than 5% of the lots have been rejected will provide assurance that no more than 0.1% of the total parts are bad.

The variables sampling procedure requires some knowledge of the statistical behavior and the dependence of the parameter being measured. For example, MIL-STD-414 requires that the parameter is known to be normally distributed and independent. In the initial characterization effort, the parameter distribution should be determined, and qualification should verify that the distribution is within an acceptable error bound of the measured distribution. For several important groups of parameters, enough data has been gathered to identify the appropriate distribution type, and characterization/qualification need only verify that the particular case is not unusual.

When the lot sample data is taken, its distribution is compared to the characterized distribution as shown in Figure 2.3.2-1 to determine whether the lot is accepted or rejected. Note that a lot with an average value worse than the characterized average value may be acceptable if its distribution is sufficiently narrow.

2.3.3 Part Numbering

It was decided early in the program to propose only two classes of hardness assured parts. For one class, the parts would be hardness assurance tested for four radiation environments: neutron fluence, ionizing dose rate, total ionizing dose, and electromagnetic pulse effects. For the other class, only total dose assurance testing would be performed. In order to maintain a proper configuration control, the device must be marked uniquely. A symbol could be added to the existing part number, used to replace an existing symbol, or a new part number could be used. The military microcircuits currently use all of the allowed 15 symbols, making addition of a symbol impractical. New part numbers could be used, but this would be undesirable since the hardness assured devices do not differ electrically from the regular devices. It was initially suggested that the slash symbol be replaced with a symbol indicating hardness assurance level, but this violates military standards for assigning part numbers. The final choice, shown in Figure 2.3.3-1, was to add four new class designators to the present class S and class B, combining the two quality classes with two radiation hardness assurance classes. Class C parts have not been included because the class is not much used, and its lower level of control is likely to be inadequate for hardness assured parts.

For the transistors and diodes, there are no existing part numbers longer than 14 characters, so the hardness assurance designator can simply be added after the other quality designating letters as shown in Figure 2.3.3-1. To maintain consistency with microcircuits, the same letters are used for JANS discrete semiconductors as for class S microcircuits, and the letters used for JANTX and JANTXV are the same as those used for microcircuit class B. JAN

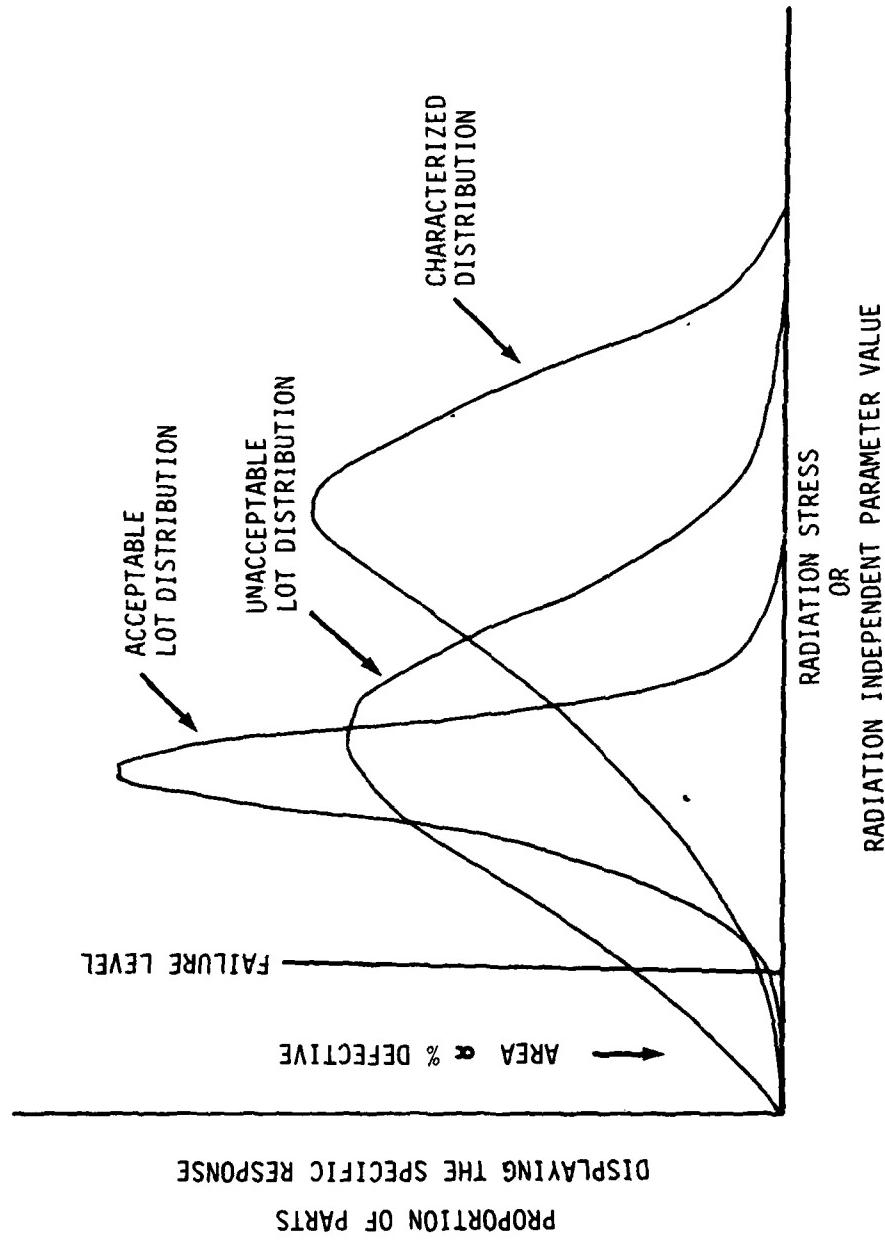


FIGURE 2.3.2-1 INSPECTION BY VARIABLES FOR PERCENT DEFECTIVE

HARDNESS ASSURANCE CLASSES

RELIABILITY CLASS	B	S
FOUR ENVIRONMENTS ASSURED	R	H
TOTAL DOSE ONLY ASSURED	T	W

MICROCIRCUITS MARKING

JANM38510/00101 CB { R OR T FOR CLASS B
H OR W FOR CLASS S

DISCRETE SEMICONDUCTOR MARKING

JANTXV 1N4557RG { R OR T
JANS 1N4557RB { H OR T

FIGURE 2.3.3-1 PART NUMBERING^{1/}

^{1/} Proposed marking subject to triservice-NASA coordination. This system is not compatible with the existing system for marking total dose hardened devices.

devices have not been included because their lower level of control is inadequate for hardness assured parts.

3.0 REVISIONS TO MILITARY SPECIFICATIONS AND STANDARDS

The changes required to MIL-M-38510, MIL-S-19500 and MIL-STD-883 to incorporate the hardness assurance requirements are included as appendices to this report. The approach to hardness assurance taken by the contract is to treat radiation as simply another element of the environment, such as temperature or vibration. Therefore, the major changes to the existing documents are in the tables that list environmental testing requirements. In each case, a group of tests for radiation effects was added to the existing tables. The other changes required are mostly in sentences that refer to the test tables and in the paragraphs on part numbering and marking.

More specifically, hardness assurance tests for qualification and quality conformance inspection of microcircuits were added to MIL-STD-883, Method 5005 as Group E. The sections of MIL-M-38510 that require qualification and quality conformance inspection in accordance with Method 5005 were changed to make the appropriate references to the new Group E. For discrete semiconductors, the qualification and quality conformance inspection requirements are included in tables within MIL-S-19500. A new table, identified as Group D inspection was added to list the hardness assurance requirements. The paragraphs referencing the tables were also appropriately revised. No changes to MIL-STD-750 were required, because it does not have a test method analogous to Method 5005 of MIL-STD-883. A review of the other existing test methods in MIL-STD-883 and MIL-STD-750 revealed that they are not affected by addition of the hardness assurance requirements, so no revisions to them are required.

It was originally considered necessary to provide a hardness assurance program appendix similar to the product assurance program, appendix A of MIL-M-38510. Because the radiation environments are being treated just like the other environments there is no need to change this appendix. It is not limited to any specific environments and is as applicable to the hardness assurance environments as it is to all of the other environments.

4.0 IMPLEMENTATION AND SCHEDULE

Implementation of the Hardness Assured Device Specification Plan will require development of hardness assured specifications for about 100 microcircuits, 50 transistors and 30 diodes. Review of the Boeing Aerospace Company Preferred Parts List and the parts usage lists of major Boeing programs indicates that such a selection of parts would satisfy 50% to 70% of the parts usage in a hardened system. To implement this effort, which is estimated to cost \$3.8 million, as shown in Figure 4.0-1, a phased program is recommended as shown in Figure 4.0-2.

The first phase is a start-up phase, beginning with the hardness assurance contractor selecting the part types for which hardness assurance specifications are required and developing a priority order for specification preparation. Specifications for the 20 highest priority parts would be prepared using the existing data and newly generated data, as required, to characterize the parts and development specification parameters and values. This effort has been estimated to require about 9 months and cost \$600K.

The second phase would consist of characterizing and specifying the remaining parts on the list and developing qualified suppliers. This phase would cost the remaining \$3.2 million and last for three years.

The schedule also shows a maintenance phase, Phase III. The cost of this phase has not been estimated, since it would be a continuing effort. It would consist of maintenance of the specifications and the incorporation of hardness assurance requirements into new detail specifications as they are generated in the future.

Figure 4.0-3 shows an estimate of the cost of testing a lot of parts to all four radiation environments. The test costs are low compared to present day costs, because it was assumed that as test methods are standardized and the business volume of standard parts increases, high speed handling techniques will be applied at hardness assurance testing facilities to reduce costs.

This estimate shows that for a lot of 1000 parts the increase over the non-hardness assured part is only 20%.

PART SELECTION		\$ 20K
CHARACTERIZATION	180 PART TYPES @ \$10K*	\$1,800K
SPEC PREPARATION & COORDINATION	180 PART TYPES @ \$ 6K*	\$1,080K
HARDNESS ASSURANCE	180 PART TYPES @ \$ 5K*	<u>\$900K</u>
	TOTAL:	\$3,800K

*THESE ASSUME MAXIMUM USE OF STANDARD TEST PROCEDURES AND HIGH RATE HANDLING EQUIPMENT

FIGURE 4.0-1 PROGRAM IMPLEMENTATION COSTS

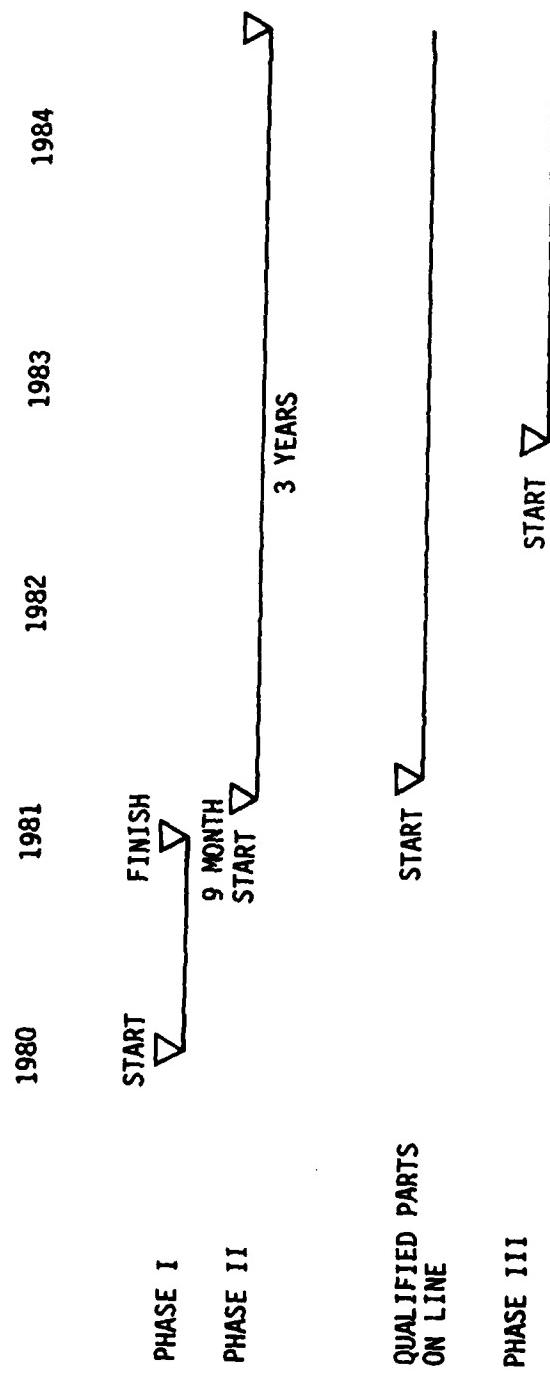


FIGURE 4.0-2 PROGRAM SCHEDULE

NEUTRONS

10 PARTS @ \$5	=	\$ 50
3 EXPOSURES @ \$60	=	180
40 ELECTRICAL TESTS @ \$.5	=	<u>20</u>
TOTAL DOSE		\$250

10 PARTS @ \$5	=	\$ 50
3 EXPOSURE @ \$40	=	120
40 ELECTRICAL TESTS @ \$.5	=	<u>10</u>
DOSE RATE		\$190

0 PARTS (NON-DESTRUCTIVE)	=	\$300
3 EXPOSURES @ \$100	=	

EMP		
10 PARTS @ \$5	=	\$ 50
4 TESTS @ \$50	=	<u>200</u>
TOTAL		\$250
NORMAL LOT COST 1,000 PARTS @ \$5	=	\$5,000
TOTAL		\$990

FIGURE 4.0-3 ESTIMATED HARDNESS ASSURANCE*

*ASSUMING MAXIMUM USE OF HIGH RATE HANDLING EQUIPMENT AND STANDARD TEST PROCEDURES

5.0 COST SAVINGS

Figure 5.0-1 shows the direct cost savings that would be realized on a typical hardened system. It assumes a program to build 100 systems, each containing 250 types of microcircuits and discrete semiconductors, 50% of which are standard and would be available as standard hardness assured parts. The hardness assurance program would cost \$3.75 million if the Hardness Assured Device Specification Plan had been implemented and \$7 million if it had not. Therefore, the first program to use standard hardness assured parts saves \$3.25 million. A second program would also save \$3.25 million, or \$6.5 million for the two programs. Since development of the standard hardness assured parts cost only \$3.8 million, the government would be \$2.7 million ahead after only two major programs used standard hardness assured parts. An additional \$3.25 million would be saved by each additional program.

Figure 5.0-1 shows only the direct costs that a program incurs by not having standard hardness assured parts available. The \$7 million is in reality greatly increased by hidden costs that are very difficult to estimate. Problems caused by procuring parts from sole sources to custom specifications have significant impact on program costs and schedules. Redesign efforts caused by the purchased parts not being as hard as predicted when the design work was being done also cost money and schedule time. If these and similar hidden costs could be accurately determined, the cost savings made possible by having standard hardness assured parts available would be greatly increased.

For smaller systems the savings is very large if one assumes a full hardness assurance program amortized over only 10^5 parts. The prospect of saving on the order of 2 to 3 million dollars of hardness assurance costs for a system supposed to cost a few tens of million all together is somewhat distorted. In such a case the designers would probably choose to overdesign the part application and perform a very limited version of a full hardness assurance program. This would reduce the actual dollar savings made possible by using

standard hardness assured parts but would substitute improvements in the confidence of the system's hardness.

	WITH STANDARDIZATION	WITHOUT STANDARDIZATION
STANDARD HARDNESS ASSURED PART PREMIUM	5 X 105 PARTS \$1/PART = \$ 500K	-0- = \$ 0
CHARACTERIZATION	125 PART TYPES @ \$10K = 1,250K	250 PART TYPES @ \$15** = 2,750K
SPEC PREPARATION	125 PART TYPES @ \$ 6K = 750K	250 PART TYPES @ \$ 6K = 1,500K
HARDNESS ASSURANCE QUALIFICATION	125 PART TYPES @ \$ 5K = 625K	250 PART TYPES @ \$ 5K = 1,250K
LOT ACCEPTANCE TESTS	125 PART TYPES X 5 LOTS/ PART @ \$1K PER LOT = <u>625K</u>	250 PART TYPES X 4 LOTS/PART @ \$1.5** = <u>1,500K</u>
	\$3,750K	\$7,000K
	SAVINGS:	\$3,250

FIGURE 5.0-1 TYPICAL * PROGRAM HARDNESS ASSURANCE COST SAVINGS

*3 MAJOR CONTRACTORS; 5 MINOR CONTRACTORS
 250 PART TYPES USED; 125 STANDARD, 125 NONSTANDARD
 10^4 PARTS PER SYSTEM X 100 SYSTEMS = 106 PARTS

**HIGHER COSTS WITHOUT STANDARDIZATION DUE TO LACK OF STANDARD TESTS PROCEDURES AND HIGH RATE HANDLING EQUIPMENT

APPENDIX A
COMMENTS ON DRAFT HARDNESS ASSURED DEVICE SPECIFICATION PLAN

The second draft of the Hardness Assured Device Specification Plan was transmitted to a wide range of contacts in government and industry. About 90 copies were sent out with a request for comments and eighteen replies were received. The replies ranged from general statements of support to six pages of detailed comments. Fortunately, the majority of the comments were quite specific about the concerns of the respondent. Most of the respondents expressed strong agreement with the basic approach of the plan even if they took exception to specific points. Since these responses represent a unique cross section of the aerospace community's thoughts on Mil-Spec hardness assurance, they are briefly recapped as follows:

- | | | |
|-------------------------|--|---|
| 1. Jerry Wishes | Director Q,R&A | Teledyne Semiconductor |
| 2. Richard A. Staffieri | Director QA | Intersil |
| 3. Leonard M. Pauplis | ----- | GTE Sylvania (ESG) |
| 4. Andy Koutalides | QC Engineering Mgr. | Raytheon Semiconductor Co. |
| 5. P. C. Boyd | Supervisor,
Components Standards
Engineering | Sperry Flight Systems |
| 6. J. W. Cecil | Supervisor, Device
Engineering | Lockheed Missiles
and Space Co. |
| 7. J. A. Henderson | ----- | IBM |
| 8. Dale M. Cole | Project Leader
Advanced Comp. Engr. | General Electric,
Aircraft Equipment |

9. J. E. Boyd	Supervisor, Engineering Parts Engineering	Westinghouse Electric
10. Jewel Moody	Mgr., NASA Standard Parts	NASA MSFC
11. G. P. Chapman	Chief TRE Branch	AFWL
12. R. E. Roberts & R. M. Cooper		Litton Guidance & Control Systems
13. G. C. Messenger		Litton Systems
14. Eligius A. Wolicki	DNA Program Area Reviewer, Hardness Assurance Program and Radiation Technology Division	NRL
15. Harvey Eisen	-----	HDL
16. Michael J. Campbell	Military/Hi-Rel Products Department	MOSTEK
17. Ben Irwin	Manager, Special Programs	MMI
18. Robert C. Radeloff	Acting Director, Engineering Standardization	DLA-DESC

<u>RESPONDENT</u>	<u>COMMENTS</u>
J. Wishes Teledyne	Expressed support for the plan.
R. A. Staffieri Intersil	Could not determine cost impact. Customers performed hardness tests and data is not made available.
L. M. Pauplis Sylvania	Be more specific about who will do the work and how the hardness assurance contractor will be selected.
A. Koutalides Raytheon	Hardness assured device symbols after Jan part numbers appears to offer considerable cost savings. Don't have cost factors in hand for radiation tests. Need specific sample sizes.
P. C. Boyd Sperry	Many systems don't need ionizing dose rate upset assurance and this should be a new class. Latchup prone structures should be outlawed. What about security of data/specs?
J. W. Cecil Lockheed	Characterization data should make data from one user usable to another.
J. A. Henderson IBM	Need to demonstrate this idea for a real part. Applications should be considered. Would greatly improve data available for medium hard parts and reduce characterization costs. Should show mean and standard deviation of part characteristics.
D. M. Cole General Electric	Lot should be redefined as a wafer lot. A standard sampling plan should be used. Stocking lots for small buys should be considered. More divisions of hardness levels than H & D may be required.

<u>RESPONDENT</u>	<u>COMMENTS</u>
J. E. Boyd Westinghouse	Part manufacturers may have difficulty subcontracting radiation test. How is range of testing selected? Part marking approach superior to approach of amendment 2 to MIL-M-38510. Expand small sample statistical approach.
J. W. Moody NASA	Earth orbit presents electron and proton radiation not dealt with in plan. Include latch up and burn out. Don't perform hardness related electrical screens after radiation tests. Specify a LTPD. Perform failure analysis.
G. P. Chapman AFWL	Recommend a more complete cost justification. Standard hardness assured parts do not eliminate the need for each program to do its own hardness assurance on some parts. Newer complex IC's may be hard to test for general application. The small size of the market may not attract much support. A more objective criteria needs to be found to reduce testing of relatively hard parameters. Mr. Chapman also identified several specific areas where objective procedures have not been well established and problems will be encountered in actually implementing the system.
R. E. Roberts & Dr. M. Cooper Litton	D class could be confused with previous ideas for a D level of quality. Procedures to select and use statistics require further definition. Test might include standard deviation as a reject parameter. How will different confidence requirements be dealt with? Radiation qualified parts may be too expensive to be used.

<u>RESPONDENT</u>	<u>COMMENTS</u>
G. C. Messenger	In several instances, the plan goes beyond the minimum, cost-effective approach. Selection of high usage parts is a good approach to maximize the benefits. Test data should be limited to carefully selected critical parameters. Failure criteria should be defined. Failure analysis should be limited to pertinent failures. An LTPD should be used. Mr. Messenger also included an extensive set of corrections/comments on examples chosen to illustrate various points.
Eligius A. Wolicki & Art Namenson NRL	Mr. Wolicki provided a detailed markup copy of the plan and some detailed results of an ongoing study of the variables statistical test methodology.
Harvey Eisen HDL	Mr. Eisen provided a detailed markup copy of the plan.
Michael J. Campbell MOSTEK	The data base for standard parts is a good idea. Soft errors in dynamic memories may be a problem. Mr. Campbell's comments also include many detailed questions of procedure.
Ben Irwin MMI	MMI is supplying parts to hardened systems and would support the planned program.
Robert C. Radeloff DLA-DESC	Mr. Radeloff provided a markup copy of the plan and extensive written comments. He stressed the need for development of procedures and methods for certification, qualification, and quality conformance.

In response to the confusion generated by some of the detailed discussions of specific examples, the final plan was extensively rewritten to clarify the approach and the discussion of examples was reduced to a more appropriate level. The final plan clarifies the points of confusion raised by the responses and is more specifically directed at defining the elements of the tasks to be performed to have standard hardness assured parts readily available for use.

APPENDIX B
CHANGES TO MIL-M-38510

This appendix presents the changes required to MIL-M-38510D, dated 31 August 1977, to incorporate the requirements for standard hardness assured parts. These changes, if issued as an amendment, would be in addition to the changes already included in Amendment 1 to MIL-M-38510D, which is dated 21 July 1978.

PAGE 4

3.1.3.r; add the following new paragraph.

"r. Radiation hardness assurance. The portion of product assurance which assures that parts continue to perform as specified or degrade in a specified manner when subjected to the specified radiation environmental stress."

PAGE 5

3.3, table; under "Requirement," after "Class S certification" insert:
"Hardness assurance certification."

3.3, table; under "Paragraph" add "3.4.1.2 and 3.4.1.2.3" for Hardness assurance certification.

3.4, line 8; insert the following sentence after line 8.

"In addition, two radiation hardness assurance options are provided that modify the class S and class B requirements without reducing them in any way, so that the hardness assured devices may directly replace the class S and class B devices."

PAGE 6

Table; under "Requirement" and before "Wafer lot acceptance" add "Radiation hardness qualification (Group E of method 5005)".

Table; under "Reference paragraph" add "3.4.1.2 and 4.4" for Radiation hardness qualification.

Table; under "Class S" add "Required for Class H and W" for Radiation hardness qualification.

Table; under "Class B" add "Required for class R and T" for Radiation hardness qualification.

Table; under "Requirement" and after "d. Group D" add "e. Group E (each lot)."

PAGE 6 (Cont.)

Table; under "Reference paragraph" add "4.5.6" for Group E.

Table; under "Class S" add "Required for Class H and W" for Group E.

Table; under "Class B" add "Required for Class R and T" for Group E.

PAGE 7

3.4.1.1.2; add the following new paragraph:

"3.4.1.1.2 Qualification of radiation hardness assured classes of microcircuits. Qualification of a product to any of the radiation hardness assurance classes shall consist of qualification to the appropriate quality and reliability assurance level (Class S or Class B) as defined in the table below, certification per 3.4.1.2.3, and hardness qualification inspection in accordance with Method 5005 of MIL-STD-883 and the requirements of this specification."

3.4.1.1.2; after new paragraph 3.4.1.1.2, insert the following table:

<u>Quality and Reliability Level</u>	<u>Four Environment Hardness Assurance</u>	<u>Total Dose Only Hardness Assurance</u>
Class S	Class H	Class W
Class B	Class R	Class T

3.4.1.2.3; add the following new paragraph:

"3.4.1.2.3 Radiation hardness class certification. Certification for the hardness assured classes shall consist of certification to the appropriate unhardened class, B or S, and certification for the radiation hardness peculiar requirements of that class. The certification procedures shall be as defined in 3.4.1.2. Revocation or suspension of the hardness class certifications shall automatically revoke or suspend all certifications except when the qualifying activity allows retention of class B or S certification when the difficulties involved are limited to the radiation hardness assurance certification."

3.4.1.2.4; renumber old paragraph 3.4.1.2.3 to 3.4.1.2.4

3.4.1.2.5; renumber old paragraph 3.4.1.2.4 to 3.4.1.2.5

3.4.1.2.6; renumber old paragraph 3.4.1.2.5 to 3.4.1.2.6

PAGE 20

4.3.2.2; after "Die shear strength test" add the following:

"Neutron exposure
Ionizing dose rate
Total ionizing dose exposure
Electromagnetic pulse exposure"

PAGE 21

4.3.3.3; add the following new paragraph:

"4.3.3.3. Resubmission of failed radiation hardness assured class lots.
Lots which will fail the distribution test may be resubmitted once with the data from both samples combined. Failure of absolute end points or deltas of Group E tests, or failure of the extended sample statistics, requires a failure analysis to identify the cause of the failure. If this data combined with previous history on the part indicates a random defect, rather than an out of control process, a second sample may be taken to satisfy an LTPD of 5 when combined with the original sample. If it is determined that the defect may be screened out, the qualifying activity shall determine the applicability of the screen to future production and the need or lack of need for additional test samples."

PAGE 22

4.4.2, line 4; after "D" insert "(and E, if applicable)".

4.4.2.1, line 2; after "D" insert "(and E, if applicable)".

4.4.2.1, line 4; delete "C and D" and substitute "C, D and E".

4.4.2.1, line 6; after "D" insert "(and E, if applicable)".

4.4.2.1.1, line 3; after "D" insert "(and E, if applicable)".

PAGE 23

4.4.2.1.3, line 11; delete "C and D" and substitute "C, D and E".

4.4.2.1.4; line 2; delete "or D" and substitute "D or E".

4.4.2.1.5, line 3; delete "and D" and substitute "D and E".

4.4.2.1.6, add the following:

"f. For Group E radiation hardness tests, the measured end points, deltas and statistical distribution of parameters."

PAGE 24

4.4.2.5; add the following new paragraph:

"4.4.2.5 Group E testing. Group E testing shall be as specified in Method 5005 of MIL-STD-883."

4.4.2.6; change old paragraph 4.4.2.5 to 4.4.2.6

4.4.2.6, line 4; after "D" insert "(and E, if applicable)".

4.4.2.6.1; change old paragraph 4.4.2.5.1 to 4.4.2.6.1

4.4.2.6.2; change old paragraph 4.4.2.5.2 to 4.4.2.6.2

PAGE 25

4.4.2.6.3; change old paragrph 4.4.2.5.3 to 4.4.2.6.3

4.4.2.6.4; change old paragraph 4.4.2.5.4 to 4.4.2.6.4

4.4.3d(3); after "D" insert "(and E, if applicable)".

PAGE 27

4.5.1, line 2: delete "C and D" and substitute "C, D and E".

PAGE 29

4.5.6; add new paragraph 4.5.6 as follows:

"4.5.6 Group E inspection for classes H, W, R and T. Group E inspection shall be performed on each inspection lot, in accordance with Method 5005 of MIL-STD-883. A separate sample shall be used for each destructive test subgroup. Transient ionization upset tests may be identified as nondestructive at the option of the qualifying agency."

4.5.7; add new paragraph 4.5.7 as follows:

"4.5.7 Group E sample selection. Samples for Group E subgroups shall be chosen at random from each inspection lot which has completed the screening requirements of 4.6."

4.5.8; change old paragraph 4.5.6 to 4.5.8.

4.5.8; line 1; delete "C and D" and substitute "C, D and E".

4.5.9; change old paragraph 4.5.7 to 4.5.9.

4.5.9; line 1; delete "C or" and substitute "C,".

4.5.9; line 2; delete "D" and substitute "D or E".

4.5.9; line 2; delete "4.3.3.1 or 4.3.3.2" and substitute
"4.3.3.1, 4.3.3.2 or 4.3.3.3".

4.5.9; line 3; delete "resubmission of 4.3.3.1" and substitute
"resubmission,".

4.5.9; line 4; delete "or 4.3.3.2,".

PAGE 41

10.1, line 2; add new sentence as follows:

"Hardness assurance sample sizes and variables data statistical procedures
are defined in the detail specifications."

APPENDIX C CHANGES TO MIL-STD-883

This appendix presents the changes required to MIL-STD-883B, Method 5005.5 dated 21 July 1978, to incorporate the requirements for standard hardness assured parts. To complete the incorporation of hardness assurance requirements into MIL-STD-883 will require completion of some hardness assurance test methods that are being prepared separately from this contract. For purposes of this appendix, these new methods have been assigned arbitrary designations such as Method XXX and Method XXY.

THE FOLLOWING PEN AND INK CHANGES ARE TO BE MADE:

METHOD 5005.5, PAGE 1, PARAGRAPH 1, line 4: After "D" insert "(and E, if applicable)".

METHOD 5005.5, PAGE 1, PARAGRAPH 1, line 6:
After "B" insert "(and E, if applicable)".

METHOD 5005.5, PAGE 1, PARAGRAPH 3.1, line 1:
Delete "S" and substitute "S, H and W".

METHOD 5005.5, PAGE 2, PARAGRAPH 3.1.3:

Add new paragraph 3.1.3 as follows:
"3.1.3 Class H and W qualification. These two classes are Class S devices with Radiation hardness assurance added. Qualification consists of Class S qualification as defined above and the additional qualification tests of Table V. If devices have previously been qualified to one of the other three hardness assurance classes, the data may be used to satisfy the requirements of Table V."

METHOD 5005.5, PAGE 2, PARAGRAPH 3.1.4:
Change old paragraph 3.1.3 to 3.1.4.

METHOD 5005.5, PAGE 2, PARAGRAPH 3.2, line 1:
Delete "S" and substitute "S, H and W".

METHOD 5005.5, PAGE 2, PARAGRAPH 3.2, line 8:
Add the following sentence:

"For Class H and W microcircuits the procedures are identical to those for Class S except that the sampling tests of Table V are added."

METHOD 5005.5, PAGE 2, PARAGRAPH 3.3, line 1:
Delete "B and C" and substitute "B, C, R and T".

METHOD 5005.5, PAGE 2, PARAGRAPH 3.3, line 2:
Delete "microcircuits shall" and substitute "classes B and C shall".

METHOD 5005.5, PAGE 2, PARAGRAPH 3.3, line 4:

Add the following sentence: "Qualification or quality conformance inspection for class R and T microcircuits is identical to that for class B except that the tests of Table V are added."

METHOD 5005.5, PAGE 10, PARAGRAPH 3.6, line 2:

Delete "and D" and substitute "D and E".

METHOD 5005.5, PAGE 10, PARAGRAPH 3.9c; line 1:

Delete "S" and substitute "S, H and W".

METHOD 5005.5, PAGE 10, PARAGRAPH 4e:

Delete "A" and substitute "A and E".

METHOD 5005.5, PAGE 10, PARAGRAPH 4f; line 1:

Delete "C and D" and substitute "C, D and E".

THE FOLLOWING TABLE IS TO BE ADDED AFTER TABLE IV

TABLE V
Group E Radiation Hardness Tests

<u>Test</u>	MIL-STD-883			<u>Quantity/1/ (Accept No.)</u>
	<u>Method</u>	<u>Condition</u>	<u>Class</u>	
			<u>H&R</u>	<u>W&T</u>
Subgroup 1 Neutron exposure	XXX	250C, unbiased		15/0 N/A
Subgroup 2 Ionization dose rate	XXY	250C, maximum supply voltage, minimum load		15/02/ N/A
Subgroup 3 Total ionizing dose exposure	XXZ	250C, maximum supply voltage	15/0	15/0
Subgroup 4	XYX	250C	15/0	N/A

- 1/ In addition to the pass/fail parameter limits or deltas of the applicable detail specification, selected parameters may be required to pass specified statistical tests.
- 2/ This test is not usually destructive and the test sample may, with approval by the qualifying activity, be subsequently used for a destructive test.

APPENDIX D

CHANGES TO MIL-S-19500

This appendix presents the changes required to MIL-S-19500F, dated 15 December 1977, to incorporate the requirements for standard hardness assured parts.

PAGE 1

1.1, line 4; add the following two sentences:

"Two levels of hardness assurance are also provided for the JANTX, JANTXV and JANS product assurance levels. These are designated by letters R, T, H and W following the product assurance identifier."

1.2.1, line 1; delete "JAN, JANTX, JANTXV, and JANS" and substitute "JAN, JANTX, JANTXR, JANTXT, JANTXV, JANTXVR, JANTXVT, JANS, JANSH and JANSW".

PAGE 2

2.1; after "MIL-STD-750" add "MIL-STD-883 - Test Methods and Procedures for Microelectronics".

3.1, line 6; delete "JAN, JANTX, JANTXV, or JANS: and substitute "JAN, JANTX, JANTXR, JANTXT, JANTXV, JANTXVR, JANTXT, JANS, JANSH or JANSW".

3.1, line 7; add the following sentence: "Unless otherwise specified, all JANS requirements apply to JANSH and JANSW devices, all JANTXV requirements apply to JANTXVR and JANTXVT devices and all JANTX requirements apply to JANTXR and JANTXT device."

PAGE 3

3.3.1.a.3; delete "JAN, JANTX, JANTXV, JANS" and substitute "JAN, JANTX, JANTXR, JANTXT, JANTXV, JANTXVR, JANTXVT, JANS, JANSH, JANSW".

Table I, delete and substitute new Table I as follows:

TABLE I PRODUCT ASSURANCE REQUIREMENTS

Requirement	Reference	JANS	JANSH	JANSW	TXV	TXVT	TX	TXR	JAN
Qualification	4.5								
a. Product assurance program and survey	3.4.2 and appendix D	X	X	X	X	X	X	X	X
b. Manufacturer certification	3.4.2.2 and appendix D	X	X			X		X	
c. Inspection and testing	4.5, 4.6	X	X	X	X	X	X	X	X
Inspection lot	4.3.1.1 and 4.3.1.2	X	X	X	X	X	X	X	X
Traceability	4.3.1.2	X	X	X	X	X	X	X	X
Inspection during manufacture	4.8	X	X						
Screening	4.6 and Table II	X	X	X	X	X	X	X	
Quality conformance inspection									
a. Group A (each lot)	4.7.4 and Table III	X	X	X	X	X	X	X	X
b. Group B (each lot)	4.7.5 (Table IVa) (Table IVb)	X	X		X	X	X	X	X
c. Group C (every six months)	4.7.6 and Table V	X	X	X	X	X	X	X	X
d. Group D (each lot)	4.7.7 and Table VI		X	X			X		

3.4.2.2, line 1; delete "for JANS" and substitute "for JANS, JANSH, and JANSW".

3.4.2.2, line 1; delete "of JANS" and substitute "of JANS, JANSH and JANSW".

PAGE 8

3.7.6.1, line 3; delete "JAN, JANTX, JANTXV, or JANS" and substitute "JAN, JANTX, JANTXR, JANTXT, JANTXV, JANTXVR, JANTXVT, JANS, JANSH, or JANSW".

3.7.6.1, line 4; delete "J, JX, JV or JS" and substitute "J, JX, JXR, JXT, JV, JVR, JVT, JS, JSH or JSW".

PAGE 10

3.9.1, line 3; after "C" insert "(and D, if applicable)".

3.9.2, line 6; after "C" insert "(and D, if applicable)".

PAGE 11

4.1.3; add new item g as follows: "g. Surveillance of radiation tests required by Table VI."

4.1.3; reletter old item g to item h.

PAGE 12

4.3.3.1; under "Method number" after "2031" add "1017.1 of MIL-STD-883".

4.3.3.1; under "Test" add "Neutron irradiation" for 1017.1.

4.3.1.1; under "Method number" after "1017.1" add "1019 of MIL-STD-883".

4.3.3.1; under "Test" add "Steady state total dose irradiation" for 1019.

PAGE 14

4.3.4.3; add the following new paragraph:

"4.3.4.3 Resubmitted lots of JANS, JANSW, JANTXVR, JANTXVT, JANTXR, AND JANTXT. Lots failing Group D tests may be resubmitted under the following conditions:

1. If the lot failed to meet the variables statistical test but did not fail any absolute parameter limits.
2. If failure analysis indicates the defect can be effectively removed by rescreening the entire lot.
3. If failure analysis indicates the defect was of a random nature and does not indicate poor design or processing practice.

Under condition 1. a new lot sample may be tested for the failed subgroup only and data combined with the initial test data. Under condition 2., with approval of the qualifying agency, the failed subgroup may be repeated with a double sample. Under condition 3., the LTPD shall be tightened to 5%, combining the old sample with the new sample for the failed subgroup."

4.4, line 2; delete "with MIL-STD-750" and "of MIL-STD-750" and substitute "with MIL-STD-750 and MIL-STD-883" and "of MIL-STD-750 and MIL-STD-883" respectively.

4.4.1, line 2; after "MIL-STD-750" add "and MIL-STD-883".

4.5.1, line 7; delete "and C" and substitute "C and D".

4.5.2, line 2; delete "and C" and substitute "C and D".

4.5.2, line 3, delete "B and C" and substitute "B, C and D".

4.5.2; add item d as follows:

"d. A sample from a subplot of each device type shall be tested for each group D subgroup."

4.5.3, line 3; delete "and C" and substitute "C and D".

4.5.4, line 2; delete "B and C" and substitute "B, C and D".

PAGE 16

4.5.8, line 5; delete "and C" and substitute "C and D".

4.5.8.2.b.3; delete "and C" and substitute "C and D".

PAGE 19

Figure 1, 4th block; add "Group D, if applicable".

Figure 1, 5th block; after "C" add "(and D, if applicable)".

Figure 1, 9th block; add "Group D, if applicable".

Figure 1, 10th block; after "C" add "(and D, if applicable)".

PAGE 20

Figure 2, 9th block; after "Group A" add "and D".

Figure 2, 10th block; after "Group A" add "and D".

PAGE 21

Figure 3, 6th block; after "Group C" add "Group D".

Figure 3, 7th block; delete "and C" and substitute "C and D".

PAGE 29

After Table V, add new Table VI as follows:

See next sheet.

PAGE 31

4.7.7; add new paragraph 4.7.7 as follows:

"4.7.7 Group D inspection. Group D inspection shall be performed in accordance with Table VI and the requirements of the detail specification. These tests are performed on each subplot of JANTXR, JANTXT, JANTXVR, JANTXVT, JANSH and JANSW devices. The failure of any lot to satisfy the hardness assurance requirements shall not be construed as failure to meet a lower level of hardness assurance or failure to meet the non-hardness related requirements of JANTX, JANTXV, and JANS."

4.7.8, renumber old paragraph 4.7.7 to 4.7.8.

4.7.8, line 1; delete "B and C" and substitute "B, C and D".

4.7.8, line 7; delete "B and C" and substitute "B, C and D".

4.7.9; renumber old paragraph 4.7.8 to 4.7.9.

PAGE 59

10.1, line 2; add new sentence as follows: "Hardness assurance sample sizes and variables data statistical procedures are defined in the detail specifications."

30.1, line 2; delete "method" and substitute "method, except for Group D tests where the detail specification define the method."

PAGE 60

30.2.1.1; add new paragraph 30.2.1.1 as follows:

"30.2.1.1 Hardness assurance sample size. The Group D hardness assurance sample size is defined in the specification. The sample size required is less than that required by LTPD sample. However, the LTPD may be used if the initial test is failed."

Table VI Group D hardness assurance tests

Test	MIL-STD-883 Method	Condition	Class HAR	Class W&T	Qualification	Sample size Lot quality conformance	LTPD
Subgroup 1 Neutron Fluence	1017.1	unbiased	Req'd		30/0	15/0	5
Subgroup 2 Total ionizing dose	1019	biased	Req'd	Req'd	30/0	15/0	5
Subgroup 3 Ionizing dose rate	-	biased	Req'd	Req'd	30/01	15/0	5
Subgroup 4 Electric overstress	-	unbiased	Req'd		30/01	15/0	5

¹The ionizing dose rate tests may not be destructive; however, devices may not be returned to stock after this test. If the qualifying activity determines that the test is nondestructive, these parts may be used to complete one of the other three Group D destructive tests.

MISSION
of
Rome Air Development Center

RADC plans and executes research, development, test and selected acquisition programs in support of Command, Control Communications and Intelligence (C³I) activities. Technical and engineering support within areas of technical competence is provided to ESD Program Offices (POs) and other ESD elements. The principal technical mission areas are communications, electromagnetic guidance and control, surveillance of ground and aerospace objects, intelligence data collection and handling, information system technology, ionospheric propagation, solid state sciences, microwave physics and electronic reliability, maintainability and compatibility.